Blood contamination affects lipid quantification in cardiac 1H MR spectroscopy

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Introduction

Localized cardiac MR-spectroscopy (CMRS) is the only method that facilitates non-invasive localization and quantification of triglycerides stored in the cytosol of the cardiac muscle cells [1], and is therefore an increasingly popular tool for evaluation of the heart metabolism. For quantification, the triglyceride signal is in general related to an internal reference, usually water. This eliminates systematic effects resulting from differences in voxel size, location, and heterogeneity in the receiver coil. However, if the volume of interest (VOI) contains any of the ventricular blood those ratios might be affected. In this work, we investigated how the lipid quantification is affected by blood contamination.

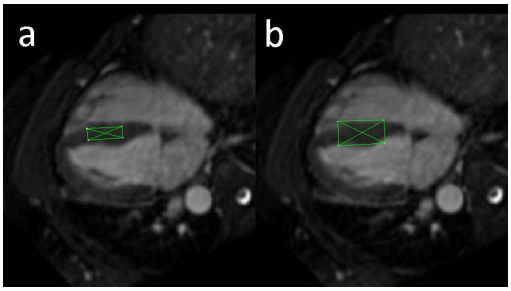

Figure 1: The two different strategies for planning of the VOI. a) VOI fitted within the septum. b) VOI enclosing the septum.

Materials and Methods

The group consists of 8 healthy volunteers; aged 22-51 years (mean 35±9 years). Imaging and localized proton spectroscopy of the human myocardium was performed using a 5-channnel cardiac coil on a 1.5T Philips Intera/Achieva MR system equipped with an MRS research package (Philips Medical Systems, The Netherlands). Both imaging and spectroscopy scans were respiratory-triggered at end expiration using a pencil-beam navigator [2] and cardiac triggered at end-systole. PRESS was used for volume selection (TE=35ms, TR=3000ms, 128 signal averages) and CHESS was used for water suppression. Eight non-water suppressed signal averages were acquired and used as the water reference (TR=6000). The VOI was defined to include 99% of the signal profile and planned on short axis and four chamber images of the heart. Two different measurements were performed on each volunteer; one where the VOI was planed to fit completely inside the ventricular septum (4.5 cm^3) and one where the VOI was planed to enclose the septum (6.75-16 cm^3) (Fig. 1). The second VOI was thus deliberately contaminated with signal from the ventricular blood. The VOIs were reconstructed on the short axis images, segmented into tissue and blood compartments, and the VOI filling factor, i.e. percent of VOI inside septum, was calculated as; VOI filling (%) = # of pixels in the tissue compartment / # of pixels in the total VOI. Spectra were evaluated using the AMARES algorithm of the jMRUI software [3]. The lipid, creatin and water signal in the spectrum was corrected for difference in VOI size and normalized within subjects.

Results

In figure 2 the lipid, creatin and water signal for different VOI fillings are shown. Figure 2b shows a correlation between the creatin signal and the VOI filling (R^2=0.65) with an incline of almost 1 (k=0.9). The correlation between the lipid signal and the VOI filling (Fig. 2a) and the water signal and the VOI filling (Fig. 2c) are much weaker and show different inclines.

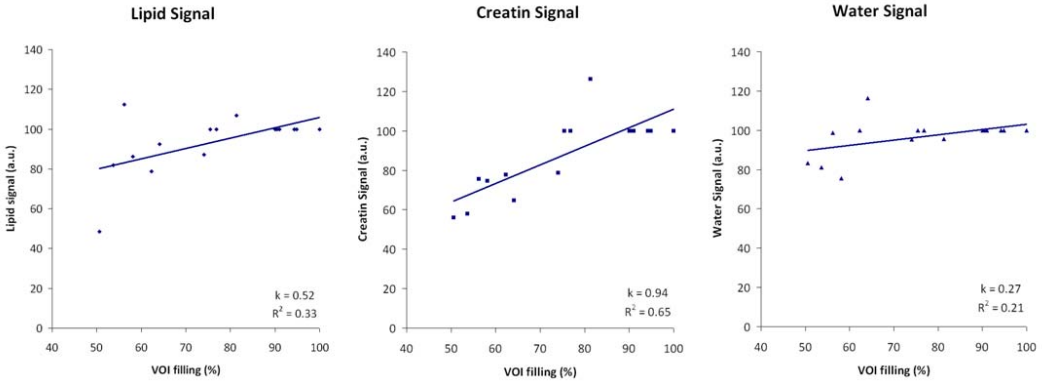

Figure 2: The MRS signal of (a) lipid, (b) creatin, and (c) water for VOIs with different VOI filling. The MRS signal is corrected for VOI size and normalized within subjects. The VOI filling is given as the percentage of VOI filled with tissue from the septum.

Discussion

If there were no signal contamination from the blood the metabolite signal would be directly correlated to the VOI filling with an incline of k=1. This appears to be the case for the creatin signal. Lipid and water show other relations and different inclines indicating different effects by blood contamination. It has earlier been argued that signal from blood could be ignored due to the black blood properties of the pulse sequence [4-5]. This study, however, shows that when the VOI includes blood it will contaminate the signal and thus affect the lipid quantification.

Conclusion

Cardiac lipid quantification is affected by the VOI filling and any blood contamination within the VOI will affect the result. Hence, studies aiming to quantify the triglycerides stored in the cytosol of the cardiac muscle cells with 1H MRS must thourughly plan the VOIs completely within the ventricular septum to avoid blood contamination.

References

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